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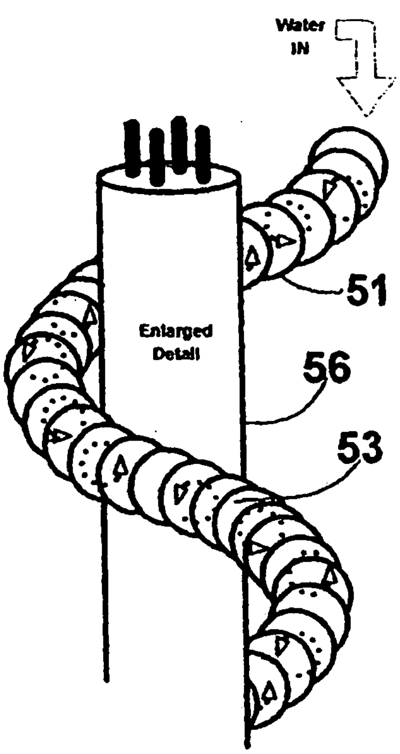
(54) Title: IMPROVEMENTS IN WATER GENERATING DEVICES



(57) Abstract: Improvements to potable water generating devices that use a condenser and blower to extract water from the air, and sterilize the water after extraction using an ultraviolet lamp (56). The improvements include sensing the ultraviolet (UV) lamp (56) output wavelength to ensure proper operation, bathing the inlet water and outlet water points in the UV light to maintain water sterility, sterilizing air entering the water handling portions of the system, running the condensed water (53) through Teflon ™ tubing (51) to improve sterilization, and sensing the ambient temperature and humidity, and in response controlling operation of the system, for example the power to the condenser, or the blower speed or output volume, to suspend water generation or to maximize efficient water generation, and/or warn the user of a low water production rate.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

IMPROVEMENTS IN WATER GENERATING DEVICES

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims benefit of the following US Provisional applications:

Serial number 60/161,761	Filed October 27, 1999
Serial number 60/161,762	Filed October 27, 1999
Serial number 60/161,763	Filed October 27, 1999
Serial number 60/161,764	Filed October 27, 1999
Serial number 60/161,765	Filed October 27, 1999

FIELD OF THE INVENTION

This invention relates to improvements in water generation devices that generate potable water from the air.

BACKGROUND OF THE INVENTION

Several attempts are being made to extract drinking water from the air by condensing this water to liquid form and treating it to drinking water standards. Many of these water treatment systems use ultraviolet light to kill microorganisms in water in order to sterilize, or disinfect it, rendering it safe to drink. These systems may attempt to monitor the condition or active operation of the ultraviolet light bulb by monitoring the electrical current to this bulb. If there is active current to the bulb it is then assumed that the ultraviolet bulb is working properly and the treatment system continues to operate. But, ultraviolet bulbs degrade in intensity and wavelength over time. These bulbs may solarize (darkening of the quartz glass material) as well, further reducing UV transmission. Also, intermittent use of a UV bulb, versus continuous use, will reduce the total hours of germicidal life of any given bulb. As a result of these factors, the UV bulb's germicidal properties may be degraded or may cease altogether without giving any indication to the user of this failure. The bulb may continue to glow for hundreds of additional

hours, and monitoring just the active electrical current to the bulb does not indicate to the user whether its germicidal affects have been compromised.

Some of these devices use ultraviolet light in their treatment systems to disinfect the water. Quartz is commonly used to separate the water from the ultraviolet lamp because quartz is UV transparent. However, over time, a light blocking film can build up on the surface of the quartz, blocking the transmission of UV light and diminishing its germicidal properties. The potential for water contamination is always present because this requires strict discipline by the user to manually keep the quartz surface clean at all times. Often, this quartz is not easily accessible to the user within the treatment system. Human nature, being what it is, leaves this method susceptible to failure, and in turn, contaminated water.

The amount of water extracted, and the energy consumed to do this, depends upon the ambient temperature and relative humidity. It would be advantageous for such a water generation device to be able to automatically detect the difference between poor and ideal conditions and have the ability to automatically operate whenever conditions are ideal, and curtail or cease operations whenever conditions are not ideal.

Most of these attempts use traditional well known water treatment methods and have temporary or permanent internal storage containers for this water. Those attempts using a permanent storage container must allow air to enter it in order to draw water out. Those with removable water containers have an exit point which is also susceptible to contaminated air migrating back into the system. Both concepts have an entry point into the system which can draw in contaminated air as well as the water to be treated. It is possible for polluted or contaminated air to come into contact with this previously treated water from any of these sources which then may re-contaminate the water.

Most of these attempts also use traditional refrigeration or dehumidification technologies. No attempt at extracting drinking water from the air addresses the issue of the wide range of temperatures these devices may experience throughout the world. Traditional refrigerants with evaporator and condenser coils are designed and engineered to work efficiently within a specific temperature range, 65 to 90 degrees Fahrenheit, or, 75 degrees to 110 degrees Fahrenheit for example. Neither work well in both ranges. If it was too hot for a system designed for 65 to 90 degrees Fahrenheit, the evaporator coils could not lower the temperatures to the dew point

needed. If the temperature was too low for a system designed for 75 to 110 degrees, the evaporator coils would become too cold and ice would form instead of water.

SUMMARY OF THE INVENTION

Ultraviolet wavelengths can range from 180 to 480 nanometers in an active bulb, but it is generally recognized that only that band of light between 250 and 260 nanometers provides actual germicidal properties. To assure that a UV bulb is providing the actual germicidal wave lengths required, it is necessary that a device be used that can detect these wavelengths and generate an action whenever the transmitted ultraviolet light falls outside of this range. For example: activating a warning device or turning the water generator off. This function is a new and unique method of detecting the lack of UV germicidal properties in a water generating device.

The ability to determine how much water can be extracted from the air can be accomplished by the combined use of a temperature sensor, a humidity sensor, a computer, and a software program. This software can then initiate the operation or shutdown of the water making device accordingly. For example, a particular water generating device could be programmed to operate only during those conditions of temperature and humidity which would yield a production rate exceeding 5 gallons per day (24 hours) and shut down whenever conditions arose that would produce a rate less than 5 gallons per day. Thus, the user can restrict the unit's operation to only those periods that provide maximum efficiency with minimal energy costs. An override switch on the water generation device could be activated to allow the unit to operate regardless of ambient conditions should the user desire to make, in this example, less than 5 gallons per day (24 hours). Traditional refrigerants with evaporator and condenser coils are designed and engineered to work efficiently within a specific temperature range, for example 65 to 90 degrees Fahrenheit, or 75 to 110 degrees Fahrenheit. Neither will work well in both ranges. If it was too hot for a system designed for 65 to 90 degrees Fahrenheit, the evaporator coils could not lower the temperature to the dew point. If the temperature was too low for a system designed for 75 to 110 degrees Fahrenheit, the evaporator coils would become too cold, causing ice to form instead of water. However, if the air flow volume through these coils was adjusted for varying ranges of temperature, this could be accomplished.

Teflon can be used in place of quartz. While Teflon is not as UV transmissive as quartz, its other properties negate the problem of film build-up. The lesser transmissive qualifies of Teflon tubing are easily offset by its flexibility, enabling it to be manipulated to expose the water to be treated to a higher intensity and duration of UV light. Also, while quartz is traditionally formed with a smooth surface, convoluted Teflon offers an uneven surface, and thus accomplishes better mixing of the water to be treated. Convoluted Teflon tubing, by nature, imparts severe turbulence to the water passing through it, greatly increasing the exposure of UV light to every drop of water. Flexible convoluted Teflon tubing also allows significant design flexibility in a water generation device.

Contamination entering through the air infiltration areas can be prevented by bathing in ultraviolet light all air entries and exits of the treatment system and storage systems.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages will occur to those skilled in the art from the following description of the preferred embodiments and the accompanying drawings in which:

Fig. 1 is a schematic diagram of UV light sensing for use in the invention;

Fig. 2 is a schematic diagram of alternative uses of the UV sensing according to this invention;

Fig. 3 is a schematic diagram illustrating the use of temperature and humidity sensors according to an aspect of this invention;

Figs. 4A and 4B schematically illustrate the prior art and an aspect of this invention, respectively, relating to water sterilization, and Fig. 4C is an enlargement of a portion of Fig. 4B;

Figs. 5A, 5B, 6A and 6B schematically illustrate the control of air flow according to another aspect of this invention; and

Figs. 7-9 are schematic diagrams illustrating the use of UV light to sterilize points of a water generation system according to an aspect of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows the ultraviolet bulb 1 transmitting ultraviolet light 2 in wavelengths between 250 and 260 nanometers. UV wavelength sensor 3 is in direct and continuous visual contact with UV bulb 1.

FIG. 2 shows the UV wavelength sensor 3 connected to controller 4 or directly to on/off switch 5. When the UV wavelength 2 falls out of the germicidal range the UV sensor 3 sends a signal to controller 4, if present, which causes an action such as turning off the water generation device or activates an alarm 6. UV sensor 3 may also send a direct signal to a switch 5, or directly to an alarm 6.

FIG. 3 shows temperature sensor 11 and humidity sensor 12 transmitting data, continuously or intermittently to programmed computer 13. The software program computes the potential water production rate at that moment and determines whether to activate the water generation device 14, allow it to continue running, or to deactivate it. A switch 15 may be present, which would override the computer and allow the water generation device 14 to be manually activated or deactivated.

FIG. 4 illustrates in simple form, the major differences of convoluted teflon 51 over straight quartz 42. The smooth quartz 42 protects the ultraviolet bulb from contact with water 44, which is flowing smoothly through tubing or piping 45. The convoluted teflon tubing 51 is wrapped around ultraviolet bulb 56 and imparts natural turbidity to flowing water 53, which insures that all of this water will receive maximum UV exposure. The flexibility of positioning components with convoluted teflon 51 in a water generation system is apparent.

Figs. 5A and B illustrate evaporator coils 61 unable to reach the dew point because the volume of the incoming air 62 is too hot. No water is condensed from the air. However, if the fan or blower 68 speed is controlled by computer 65, the evaporator coils 63 become capable of lowering the lesser amount of hot air 64 to the dew point and water 69 is formed and collected. Computer 65 obtains data from temperature sensor 66 and humidity sensor 67 and it computes the maximum air flow that can be used and adjust the speed of variable speed fan or blower 68 accordingly.

Figs. 6A and B illustrate evaporator coils 71 unable to reach the dew point because the volume of the incoming air 72 is too cool and icing occurs. No useful water is condensed from the air. However, if the fan or blower speed 78 is increased by the computer 75, the evaporator coils 73 become capable of attaining the dew point, which is above the freezing point, and water 79 is formed and collected. Computer 75 obtains data from temperature sensor 76 and humidity sensor 77 and it computes the maximum air flow 74 that can be used and adjusts the speed of variable speed fan or blower 78 accordingly.

Figs. 7-9 illustrate the use of ultraviolet (UV) light to sterilize air inlet points of a potable water generation system of this invention, to maintain sterility. Fig. 7 shows a water generating device with a permanent, or semi-permanent water storage reservoir 87. As water vapor is condensed to liquid form, it is collected in device 81, where it is carried through UV transmissive tubing or plumbing 83 into water treatment system 85, which itself may be partially or wholly contained within water reservoir 87. In some configurations of the system, additional reservoirs 96 and/or 97 may be used.

Plumbing 83 also permits air to enter treatment system 85. Strategically placed UV lamp 84 sterilizes this air as its microorganisms 82 pass by and are irradiated by UV light from lamp 84. This thus provides a sterile entrance into the water treatment system; no live airborne or water borne microorganisms 82 can enter the water treatment system by this pathway.

Reservoir 87 includes air vent 88, which is required in order for air to replace water that is withdrawn from reservoir 87. By situating air vent 88 in the path of UV light from lamp 84, air entering the system through inlet 88 is also sterilized. If this proximity cannot be accomplished, and air tight hose or the like can be attached to vent 88, with its opening proximate lamp 84, to sterilize air entering the system at this point.

Faucet or spigot 86 is the final exit point of water from the system, unless additional reservoirs 96 and 97 are included in order, for example, to provide hot and/or cold water. Each spigot 86 can be made sterile by use of an integrated or proximate UV source 90. Any air entering through the spigot would be sterilized.

Reservoir 96 illustrates another means to provide a sterile air vent 98, when the vent is not in close proximity to the UV lamp 84. Air vent 98 is extended to be in close proximity to lamp 84 by air hose 92. Thus, only sterile air can enter reservoir 96.

Similarly, for reservoir 97, and additional UV lamp 99 is shown proximate air vent 102 to sterilize air entering the system through this vent.

Fig. 8 depicts another similar arrangement with removable container 7A. UV transmissive tubing or plumbing 122 is connected to connection 118, and ends in close proximity to UV light source 114 to accomplish a sterile entrance that kills or sterilizes microorganisms 9A. Tubing or plumbing 118 protects the system from microorganisms 9A migrating back into the system whether or not removable water container 7A is in place. Also shown is temporary

water collector 123 with vent 124 extended to close proximity to UV source 114 by hose or tubing 125.

Fig. 9 depicts another arrangement with external reservoir 7B, having air hose or tubing 143 to extend vent 8A to close proximity to UV source 134. Also shown is the use of an extended UV transmissive hose portion 144 that provides a longer air treatment path than just the tubing opening, so that the treatment time is increased. Tubing 144 could also be coiled around lamp 134 to increase exposure time.

The use of one or more UV sources, placed such that each air entry point into the system is properly bathed in UV light, ensures sterilization of air entering the water-containing or transporting portions of the potable water generator of this invention, thus helping to maintain water sterility. Extended air vents help accomplish this result using a minimum number of UV lamps, preferably one.

Although specific features of the invention are shown in some drawings and not others, this is for convenience only as some feature may be combined with any or all of the other features in accordance with the invention.

Other embodiments will occur to those skilled in the art and are within the following claims:

What is claimed is:

1. An improved potable water generating device that extracts water from the air using a condenser system, comprising:

an ultraviolet (UV) lamp for sterilizing condensed water;

a UV detector means for detecting light from the lamp in the range of about 250-260 nanometers; and

means, responsive to the detector means, for controlling an aspect of the water generating device, when there is insufficient germicidal light intensity in the 250-260 nanometer range.

2. The improved water generating device of claim 1 wherein the controlled aspect is the condensation of water.

3. The improved water generating device of claim 1 wherein the controlled aspect is a warning to the user.

4. The improved water generating device of claim 1 wherein the controlled aspect is the water treatment.

5. An improved potable water generating device that extracts water from the air using a condenser system having an air blower, comprising:

an ambient air temperature sensor and humidity sensor;

a controller, responsive to the sensors, for affecting the water generation by the condensing system based upon the temperature and humidity detection.

6. The improved water generation device of claim 5 wherein the controller controls the volume of air from the air blower.

7. The improved water generating device of claim 5 wherein the controller controls the power to the blower.

8. The improved water generation device of claim 5 wherein the controller suspends water production.

9. The improved water generation device of claim 5 wherein the controller warns the user of a predetermined condition regarding the water production rate.

10. An improved potable water generating device that extracts water from the air using a condenser system, and including a condensed water handling system including a water inlet and water outlet, comprising:

at least one ultraviolet (UV) lamp arranged to bathe the water inlet and water outlet in UV light, to sterilize the water and air in the water handling system.

11. The improved water generating device of claim 10 wherein each air entry point to the water handling portion of the system is also bathed in UV light.

12. An improved potable water generating device that extracts water from the air using a condenser system, and including a condensed water handling system including a water inlet and water outlet, comprising:

Teflon tubing for carrying water through at least a portion of the water handling system; and

an ultraviolet (UV) lamp for bathing the Teflon tubing in UV light, to sterilize water in the water handling system.

Figure 1

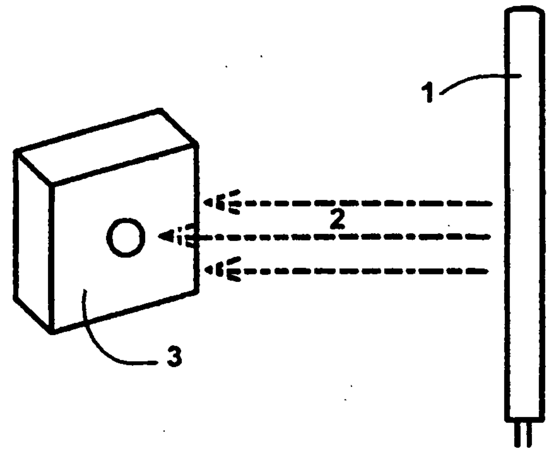


Figure 2

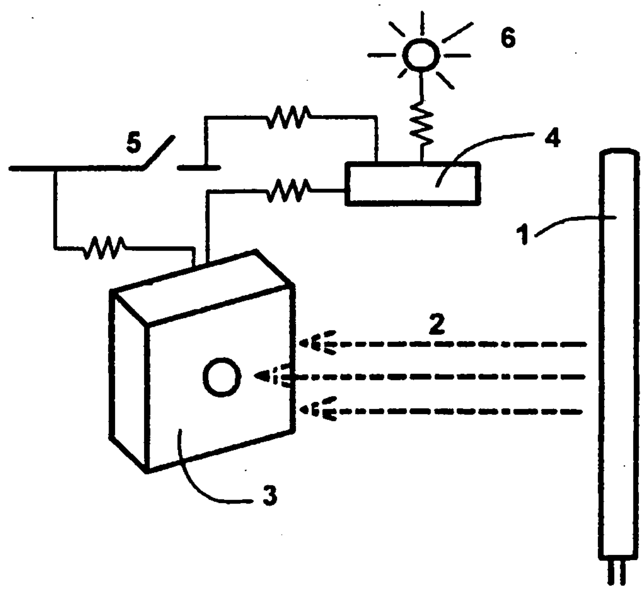
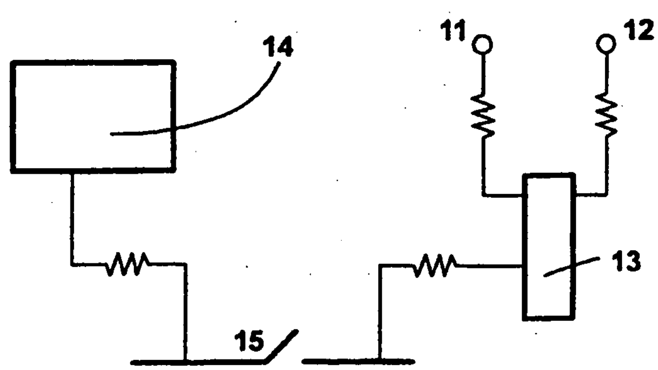


Figure 3



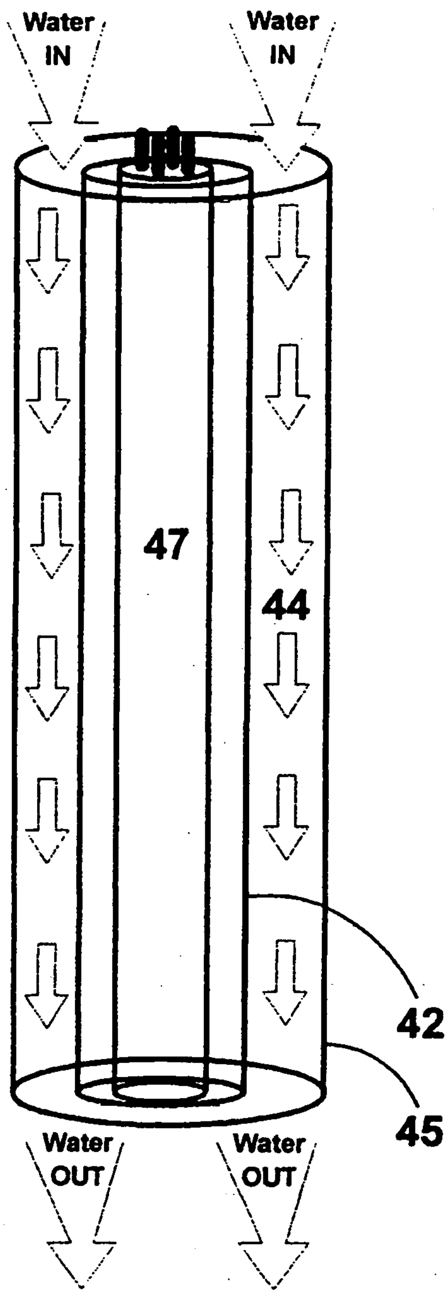


Figure 4A
Prior Art

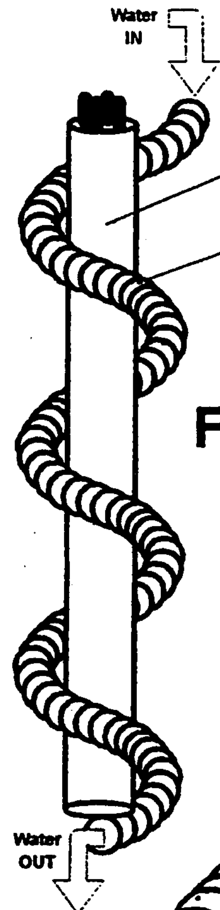


Figure 4B

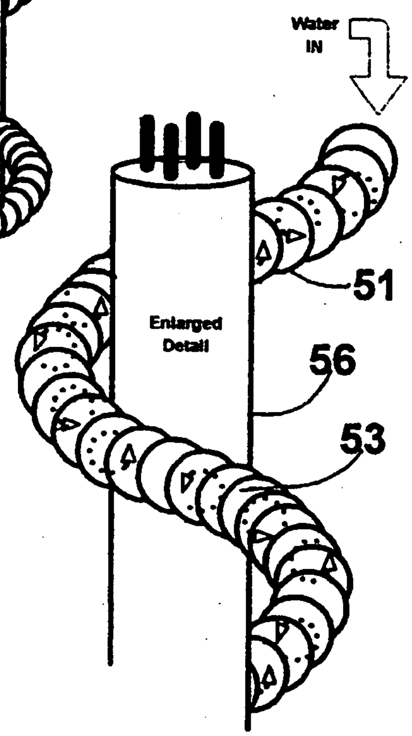


Figure 4C

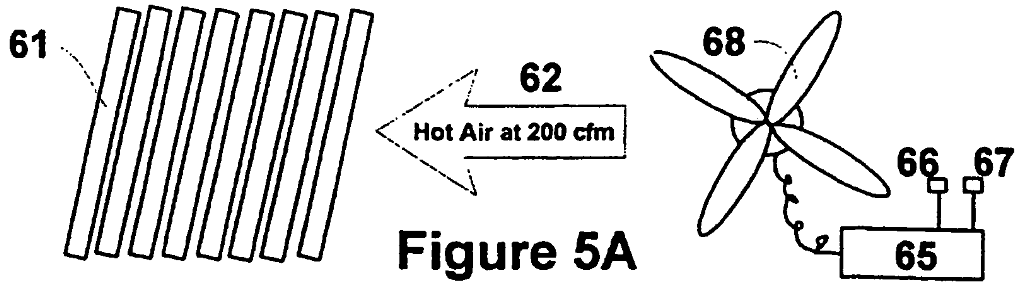


Figure 5A

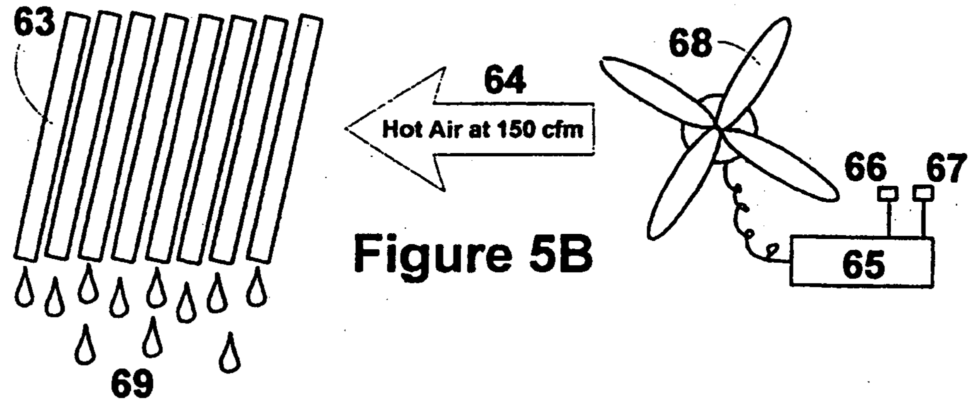


Figure 5B

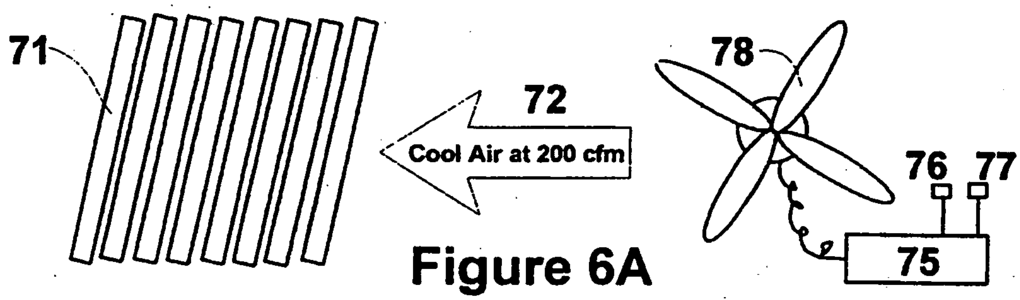


Figure 6A

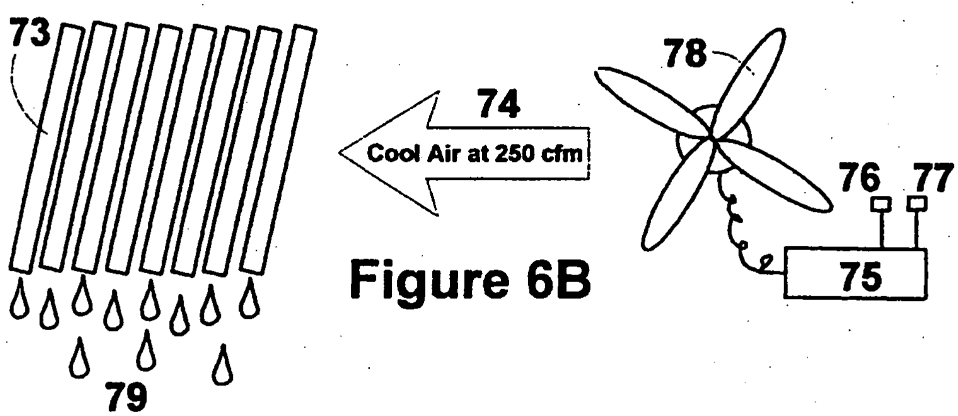
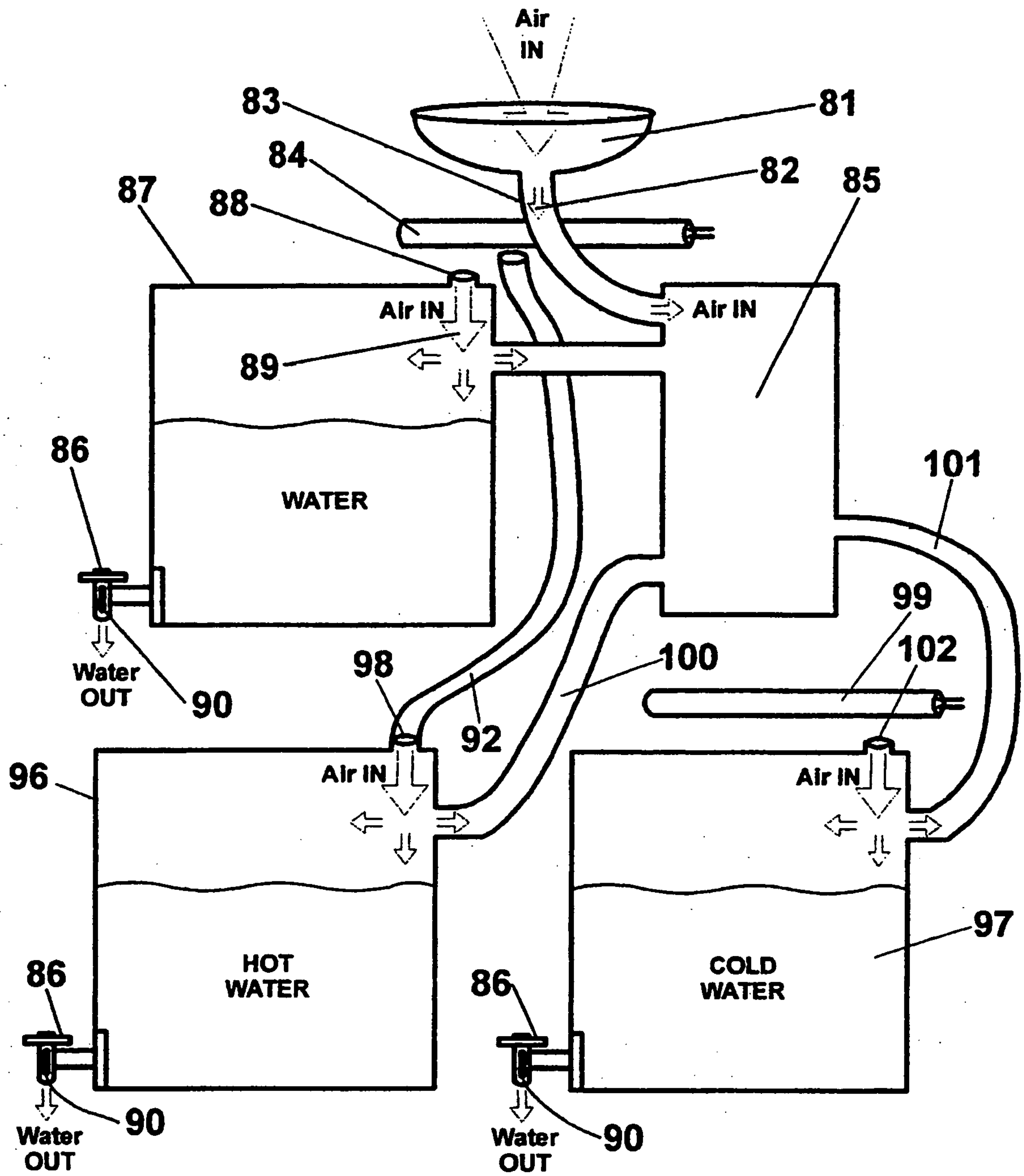


Figure 6B


Air
IN
83
81
84
82
85
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88
Air IN
Air IN
89
86
WATER
101
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102
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90
98
100
92
96
Air IN
Air IN
97
HOT
WATER
COLD
WATER
86
86
Water
OUT
90
Water
OUT
90

Figure 7

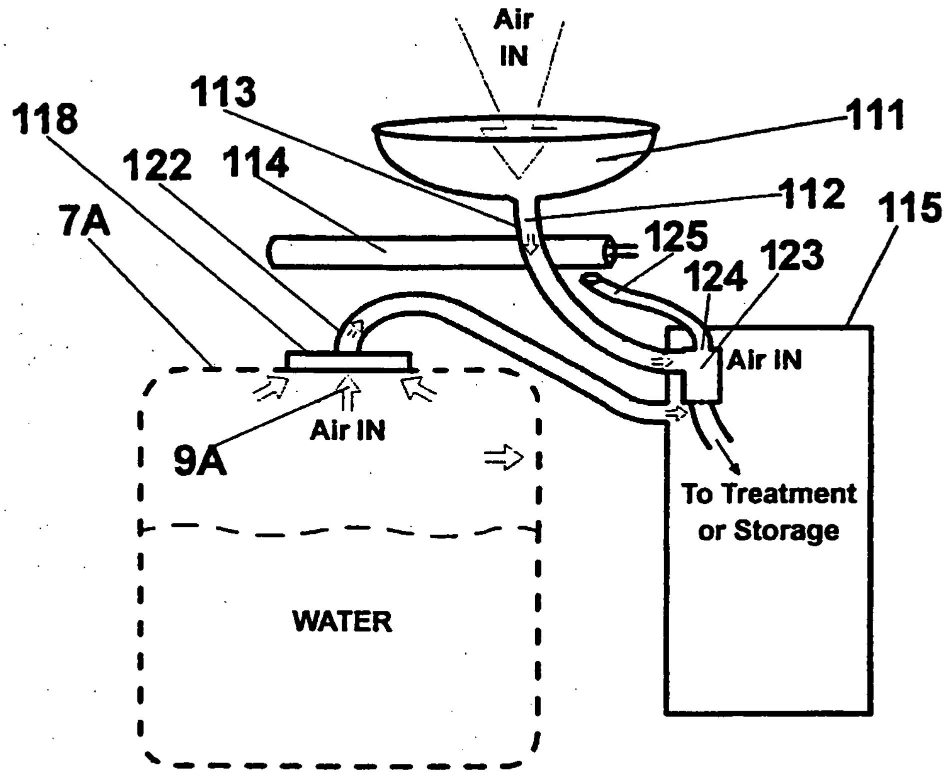
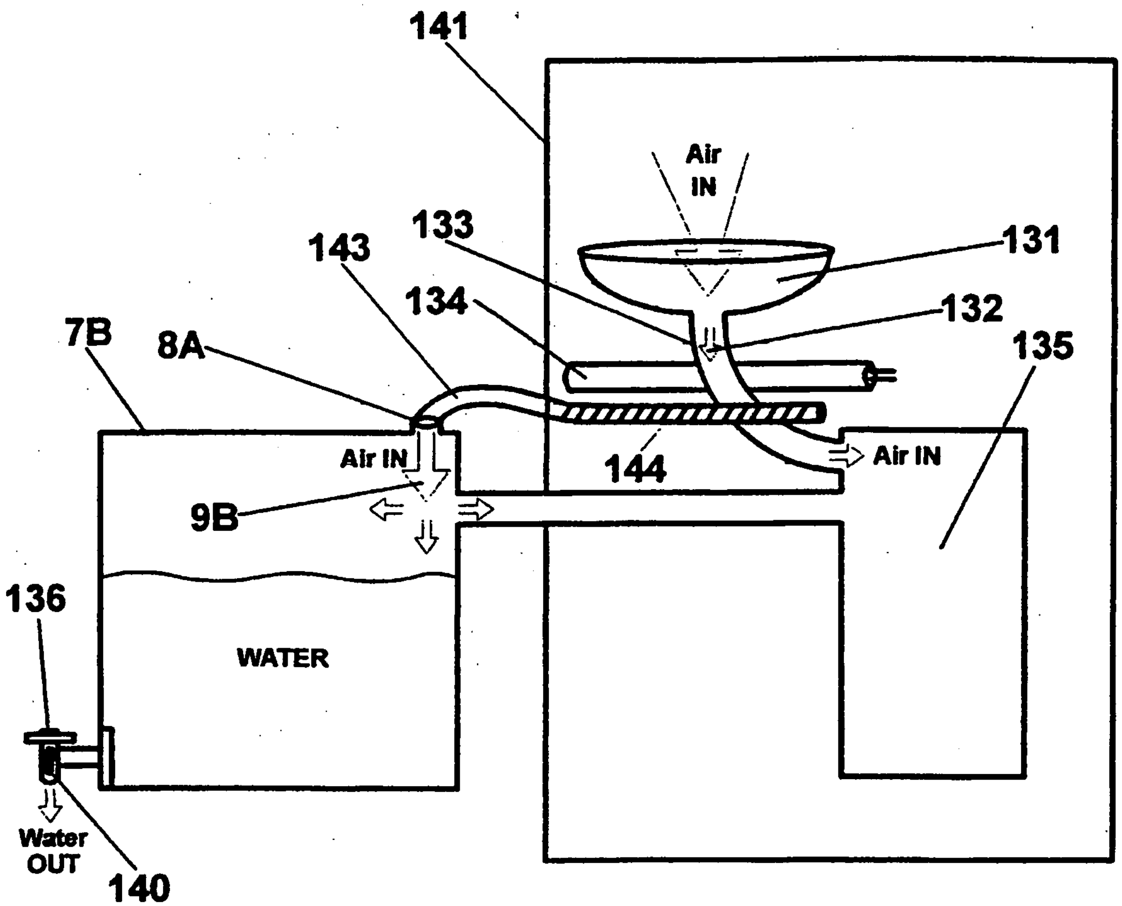

Air
IN
113
111
118
122
114
112
115
7A
125
124
123
Air IN
Air IN
9A
To Treatment
or Storage
WATER

Figure 8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Air
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134
132
7B
8A
135
Air IN
Air IN
144
9B
136
WATER
Water
OUT
140

Figure 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/29358

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) :CO2F 1/32
US CL :210/85
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,203,989 A (REIDY) 20 April 1993, see col. 4 line 39 through col. 8 line 62	1-12
Y	US 5,474,748 A (SZABO) 12 December 1995, see col. 3 line 9 through col. 4 line 63	10, 11
Y	US 5,366,705 A (REIDY) 22 November 1994, see col. 3 line 19 through col. 4 line 34	12
A	US 5,553,459 A (HARRISON) 10 September 1996	
A	US 5,845,504 A (LEBLEU) 08 December 1998	

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 JANUARY 2001	25 JAN 2001

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B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

210/85, 96.1, 109, 143, 149, 177, 180, 181, 192, 198.1, 199, 205, 257.1, 258; 55/217, 269, 279; 62/93, 272; 250/429, 434, 437; 422/186.3